with the speed, as computed according to Thomson's theory, is shown in the accompanying curve. Ordinates represent the apparent increase in mass, while abscissæ give the corresponding speeds. The speed of light is put equal to unity. It will be noticed that the ordinates remain nearly constant up to a speed of about eight-tenths that of light, after which the variation is rapid. In quantitative experiments on the kathode rays the speed has never exceeded one-half that of light. Previous experiments therefore afford no opportunity of testing the theory. The problem of increasing the speed still further is certainly a most promising subject of experimental investigation.

Since the apparent increase in mass is due to the energy of the field moving with the charge, it would appear that the amount of the increase must depend upon the form of the tube through which the rays pass. So far as I am aware, no experiments have heretofore been made to test this point. It may be that the variation, if it exists, is too small to be detected.

The suggestion has recently been made that perhaps the whole mass of the corpuscle is fictitious; that we really have to do with free electric charges, or electrons, existing apart from matter. This view is even more startling than that which makes the corpuscles smaller than atoms. The novelty of the suggestion is certainly not to be regarded as a serious objection. But direct experimental evidence in favor of this view is as yet lacking. Here, too, it appears to me that a quantitative study of the kathode rays *at the greatest attainable velocities* offers the most promising means of testing the theory.

We see that in this subject, as in every branch of natural science, each step in advance suggests still more important problems for further study and aids in their solution. In the kathode rays we have gained a new weapon with which to attack the great problems of ether and matter. What results will be achieved no one can predict. But great as have been the advances during the past decade, we can scarcely doubt that the progress during the decade that is just beginning will be even greater.

Ernest Merritt.
Cornell University.

Mathematics and Astronomy at the American Association.

The meeting of Section A was arranged with a view to complete co-operation with the Astronomical and Astrophysical Society in the astronomical part of the program and with the American Mathematical Society in the mathematical part. The full effect of such co-operation was secured by means of joint sessions, Section A meeting in joint session with the Astronomical Society on Tuesday and on Wednesday morning, and with the Mathematical Society in joint session or as guests, Wednesday afternoon, Thursday, and Friday. From this arrangement Section A received the benefit of adding to its program the papers of the two affiliated societies and having the presence of their members in its meetings while in turn, it gave the same aid to them. It is to be hoped that every year in which it is practicable some such arrangement for co-operation may be made.

Reports of the meetings of the Astronomical and Astrophysical Society and the American Mathematical Society will be published separately, hence it would be out of place to here discuss any of the papers presented by them. Among the papers of Section A, that of Henry S. Pritchett, who is leaving the Superintendency of the Coast and Geodetic Survey to become President of the Massachusetts Institute of Technology, is of perhaps the widest general interest; it is on the 'Functions, Organization and future Work of the U. S. Coast Survey.'

Dr. Pritchett divided his paper into three parts.

1. What is the purpose of the Service? The principal purpose he says is to make complete surveys and charts of the coasts of the United States. Added to this is the work of geodesy and the magnetic observations on land and sea.

2. Is it properly organized to carry out this purpose?

In the original organization the work was mostly in the hands of the army and navy. There has, however, been a complete change in this and with July 1, 1900, the Survey becomes entirely civilian. Within the last three years there has been a reorganization with the idea of developing a clear line of responsibility from the head of the service to each employee and with the further purpose of dividing the work so as to secure a more direct supervision of it.

3. What lines of work should it follow to accomplish the purpose in view?

The work has been planned as follows: First, a re-survey of parts of the mainland of the United States coasts and surveys of the coasts of Porto Rico, Hawaii, the Philippines, and Alaska. Second, the completion of an arc extending along the ninety-eighth meridian from the Rio Grande to the Canadian border, and the completion of the precise level net for the United States. Third, a general magnetic survey of the country and the waters adjacent.

Another paper of great interest and importance was Dr. G. A. Miller's 'Report on Groups of an Infinite Order.' The theory of groups in mathematics is of recent development but has assumed a place of fundamental importance. It is to reports from those who have made a special study of groups that we must look for an adequate survey of the subject as it stands to-day. Section A is especially fortunate in having had three reports which are supplementary to each other, at the last three meetings; the first of these reports was given at the Boston meeting by Dr. G. A. Miller and was on 'The Modern Group Theory'; the second, 'Report on the recent Progress in the Theory of Linear Groups' was given by Professor L. E. Dickson at Columbus, and the third is the one whose title is given above.

The following is the list of papers read before Section A:

'Miss Catherine Wolf Bruce,' by Miss Mary Proctor.

'Report on the Work of the Columbia College Observatory,' by J. K. Rees.

'Variations of Latitude,' by G. A. Hill.

'The Functions, Organization and Future Work of the United States Coast and Geodetic Survey,' by H. S. Pritchett.

'The Precise Level Net of the United States and a New Levelling Instrument,' by J. F. Hayford.

'New Light on Ancient Eclipses,' by J. N. Stockwell.

'The Case Almucantor,' by C. S. Howe.

'Standards of (faint) Stellar Magnitudes,'* by E. C. Pickering.

'Variations of Brightness of Stars in m 3,'* by S. J. Bailey.

'On the Spectroscopic Determination of Motion in the Line of Sight,' by W. W. Campbell.

'The Velocity of Meteors from the New Haven Observations,'* by W. L. Elkin.

'Parallax of Stars with Large Proper Motions,'* by F. L. Chase.

'On the Prediction of Occultations,'* by G. W. Hough.

'The Comparative Accuracy of the Transit Circle and the Vertical Circle,' by G. A. Hill.

'The Propagation of the Tide Wave,' by T. J. J. See.

'The Dimensions and Density of Neptune,' by T. J. J. See.

'Photometric Observations of Eros,' by H. M. Parkhurst.

'Secular Variations of the Motions of the Planets,' by J. N. Stockwell.

'A New Method of Finding the La Place Coefficients in the Theory of Planetary Perturbations,' by J. N. Stockwell.

'On a Method of photographing the entire Corona, employed at Newberry, S. C., for the total Solar Eclipse, May 28, 1900,' by W. G. Levison.

'Some Remarkable Properties of Recurring Decimals,' by Edgar Frisby.

* Astronomical and Astrophysical Society paper.

'History of the Complex Number,' by G. T. Sellew.

'The Motion of a Top taking into account the Rotation of the Earth,'** by A. S. Chessin.

'Kelvin's Treatment of Instantaneous and Permanent Sources extended to certain cases in which a Source is in Motion,'** by James McMahon.

'Oscillating Satellites',** by F. R. Moulton.

'On a Mechanism for drawing Trochoidal and allied Curves,'** by F. Morley.

'On Surfaces sibi-reciprocal under those contact Transformations which transform Spheres into Spheres,'** by P. F. Smith.

'On Singular Transformations in the Real Projective Group of the Place,'** by H. B. Newson.

'Report on Groups of an Infinite Order,' by G. A. Miller.

'On the Metabelian Groups whose Invariant Operators form a Cyclical Subgroup,' by W. B. Fite.

'Definitions and Examples of Galois Fields,' by L. E. Dickson.

'Construction Problems in non-Euclidean Geometry,' by G. B. Halsted.

'The Expression of a Rational Polynomial in a Series of Bessel Functions of the nth Order,' by James McMahon.

'Sundry Metrical Theorems connected with a special Curve of the 4th Order,' by F. H. Loud.

'The Directive Force of Philosophy upon Mathematics,' by Miss M. E. Trueblood.

'Die Hesse'sche und die Cayley'sche Curve,' ** by Paul Gordan.

'On the Rational Quartic Curve in Space,'** by F. Morley.

'On a Special Form of Annular Surfaces,'** by Virgil Snyder.

'On Hyper-complex Number Systems,'** by H. E. Hawkes.

'Application of a Method of d'Alembert to the Proof of Sturm's Theorem of Comparison,'** by Maxime Bôcher.

'Theorems on Imprimitive Groups,'** by H. W. Kuhn.

'A Simple Proof of the Fundamental Cauchy Goursat Theorem,** by E. H. Moore.

'On the Existence of the Green's Function for simply connected plane Regions bounded by a general Jordan Curve, and for Regions having a more general Boundary of positive Content,'** by W. F. Osgood.

'Quaternions and Spherical Trigonometry,'** by J. V. Collins.

'The Reduction of Binary Quantics to Canonical Form by Linear Transformation,'** by Miss B. E. Grow.

** American Mathematical Society paper.

'Some Remarks on Tetraedral Geometry,'** by H. E. Timerding.

Organized discussion of the question, What courses in Mathematics should be offered to the student who desires to devote one-half, one-third, or one-fourth of his undergraduate time to preparation for graduate work in Mathematics.** Opened by J. Harkness, E. H. Moore, F. Morley, W. F. Osgood and J. W. A. Young.

WENDELL M. STRONG,
Secretary.

PHYSICS AT THE AMERICAN ASSOCIATION.

IT was happily arranged this year that the Physical Society should meet with Section B, and this contributed to ensure a better attendance than was at first anticipated.

There were 29 papers presented before Section B, and 13 before the Physical Society. All but four were read.

The prominent characteristic of the papers presented was the care and thoroughness with which the experimental work forming the basis of the communications had been carried out. In this we see the influence of the German University training which so many of our physicists have received, but in addition to this there is superadded an ingenuity, and an adaptation of means to an end which is peculiarly American, and the result is a series of papers of the most admirable character.

Possibly the paper which excited most general interest was that of Professor R. W. Wood, on the 'Photography of Sound Waves.' The excellent photographs of the sound waves themselves, in practically every phase of transmission and reflection, and the kinetoscopic reproductions of their movement certainly marked an epoch in the history of the subject. A second paper 'On the application of the Schlieren method to the microscope,' illustrated a method apparently destined to be of the greatest value.

Another extremely valuable paper was that of Dr. Bedell, on 'Copper Saving in

** American Mathematical Society paper.